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(54) An orthopaedic hip hinge for casts and orthoses

(57) An orthopaedic hip hinge, has a first horizontal axis which accommodates flexion and extension motion of the hip with optional means for restricting angular travel. A second horizontal axis at right angles to the first, accommodates abductive and adductive motion of the hip and is provided with optional adjustable locking means (39, 40, 41) for setting abduction to a plurality of fixed positions. The mechanism of the second axis is cranked laterally to ensure that during abduction it does not impinge on a cast, orthosis or limb. The hip hinge has upper and lower hinge arms (1, 11), offset during manufacture, to provide good clearance over the hip. The upper hinge arm is fitted with a waistband which is provided with a demountable, adjustable belt and harness. The lower hinge arm is fitted with a headplate which may be removed from and re-assembled to the said hinge arm.

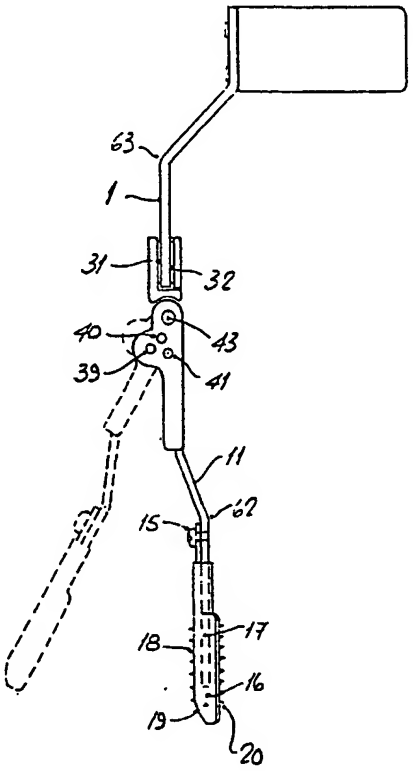

FIG. 2.

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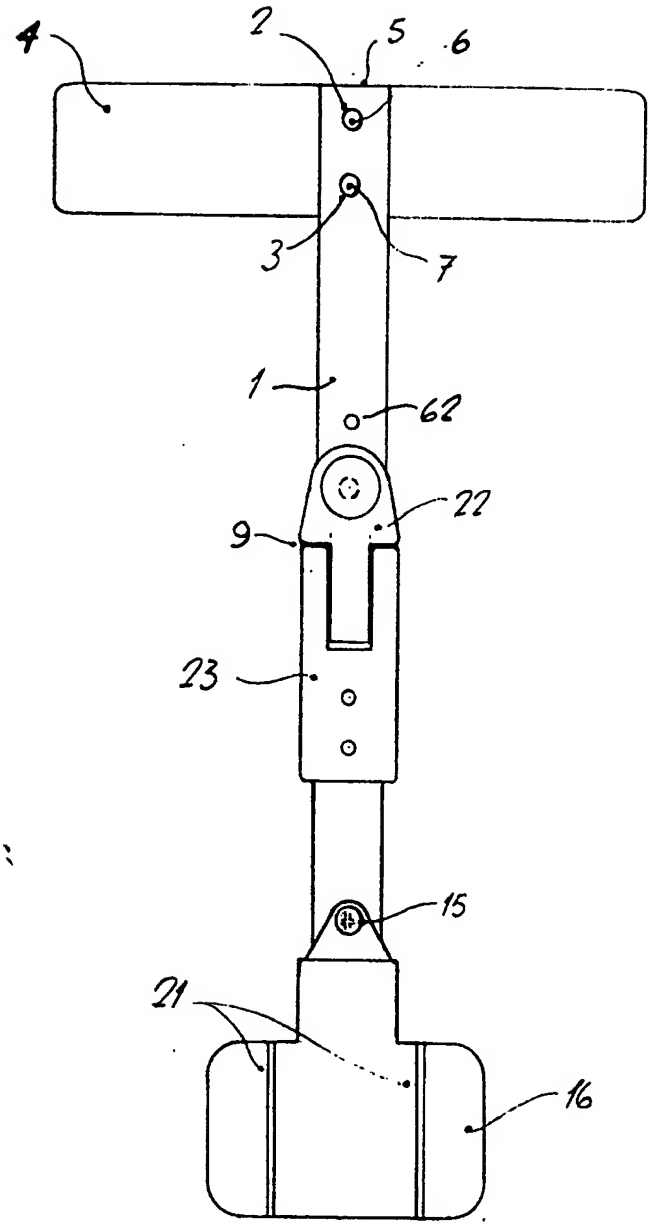


FIG. 1a.

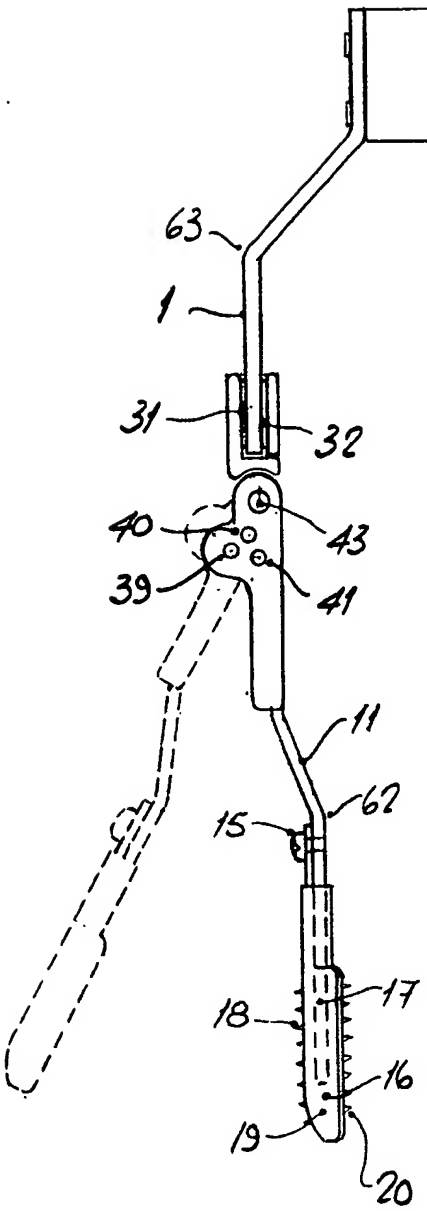


FIG. 2.

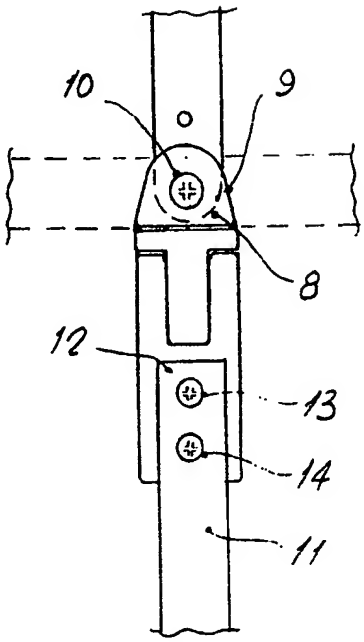


FIG. 1b.

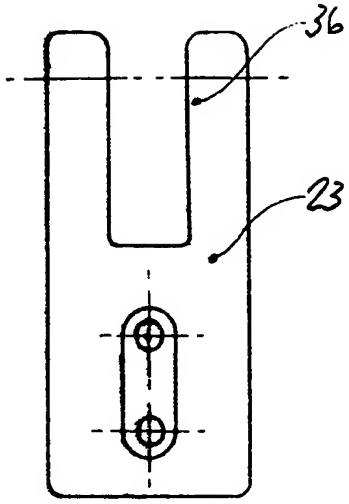


FIG. 3a.

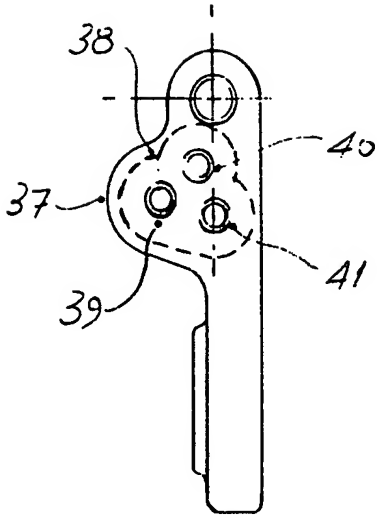


FIG. 3c.

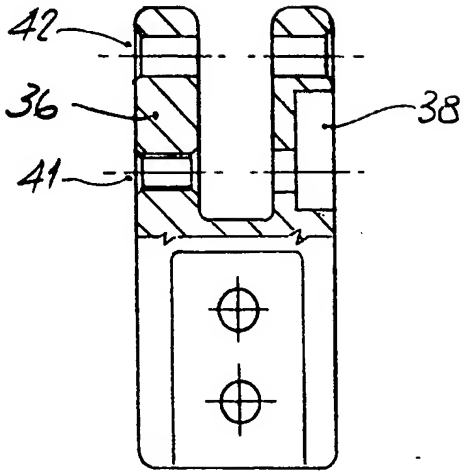


FIG. 3b.

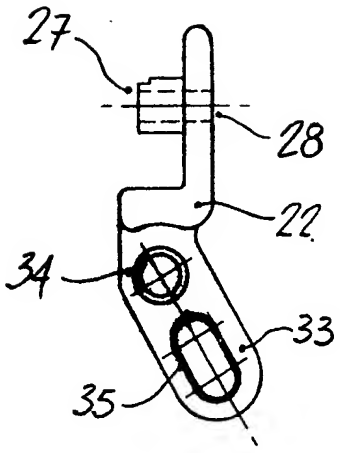


FIG. 4b.

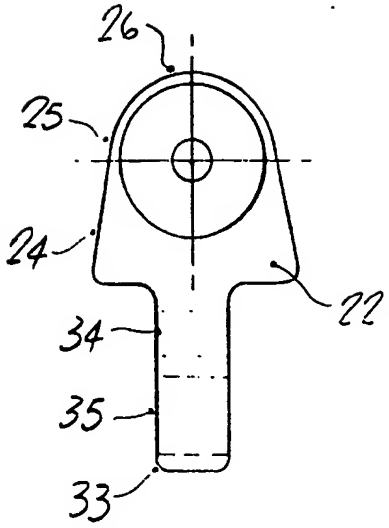
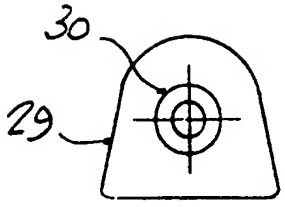


FIG. 4a.



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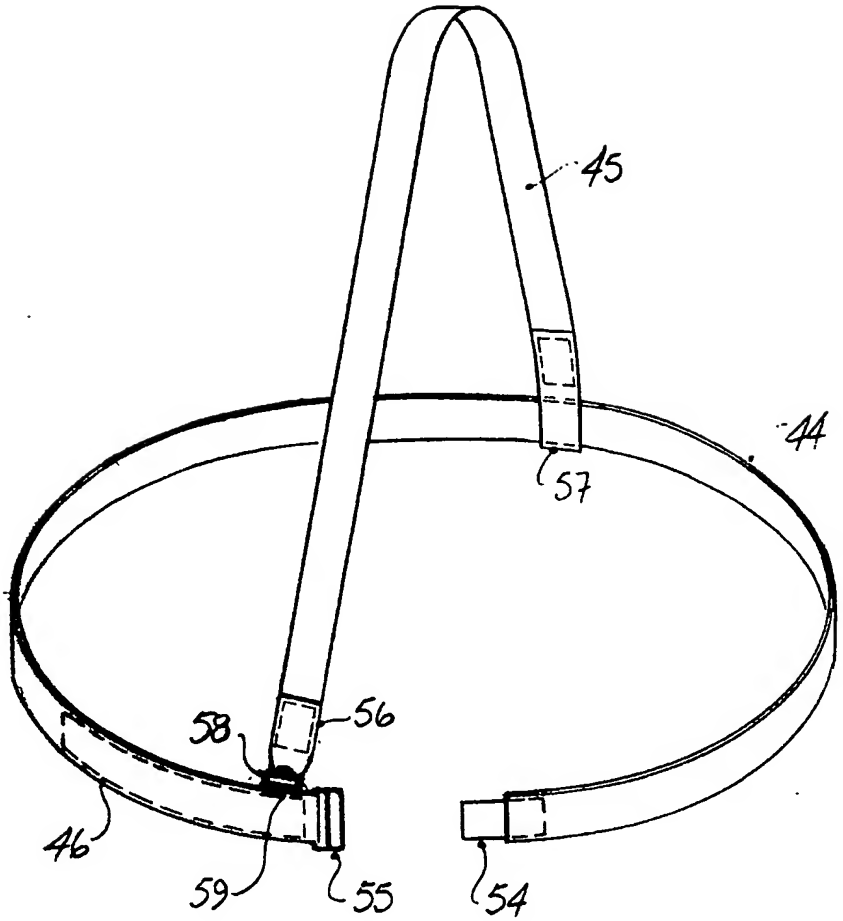

FIG.6a.

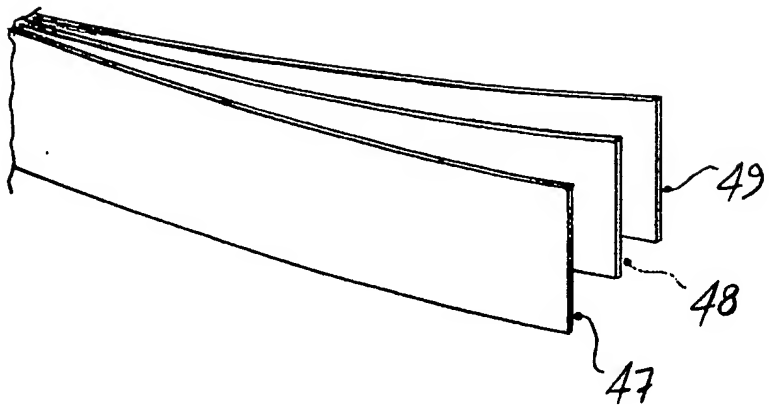

FIG. 6b.

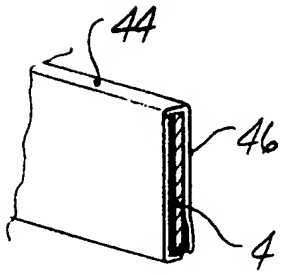

FIG. 6c.

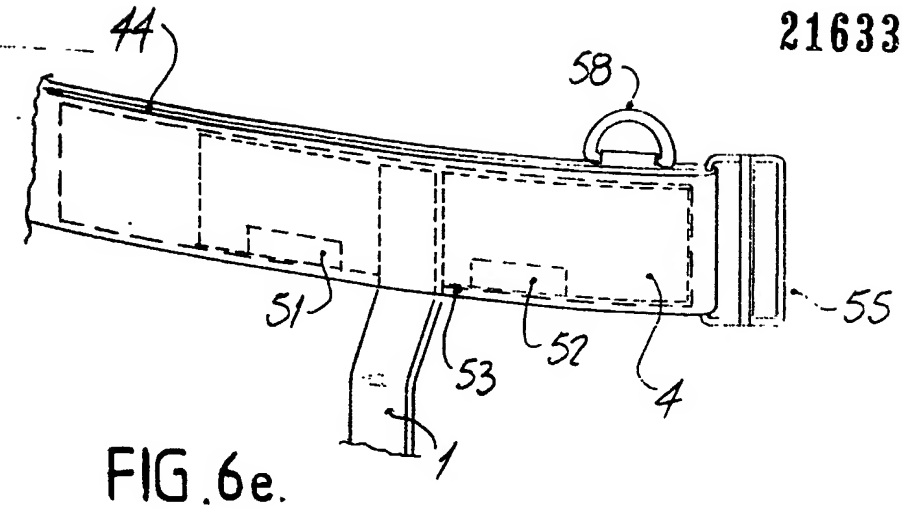

FIG.6e.

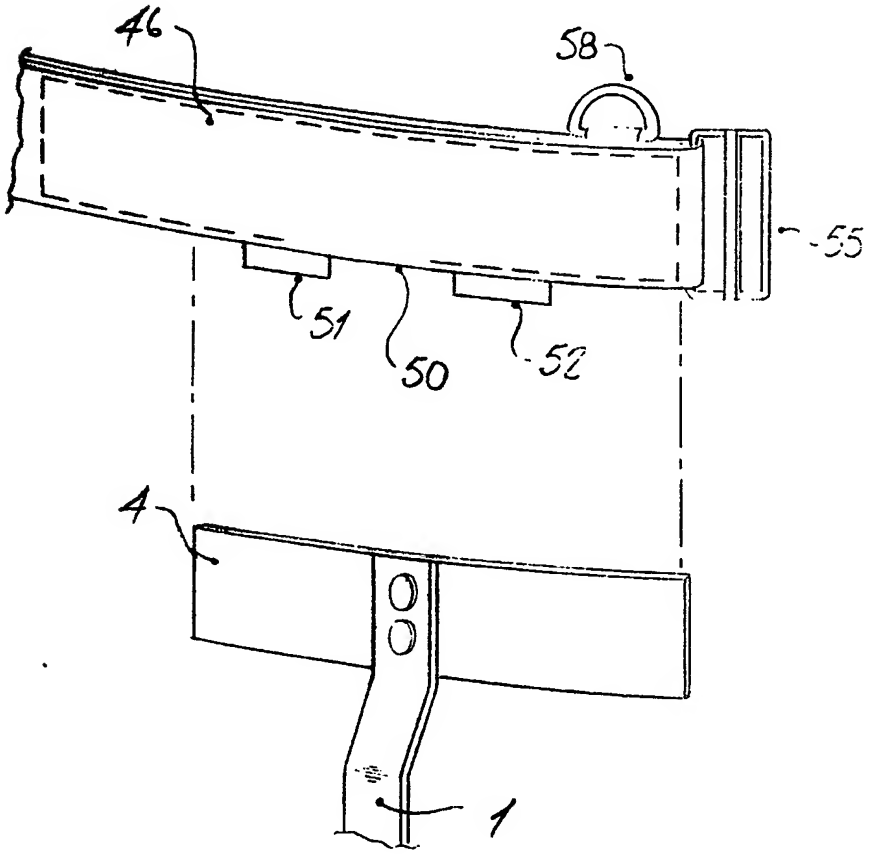

FIG.6d.

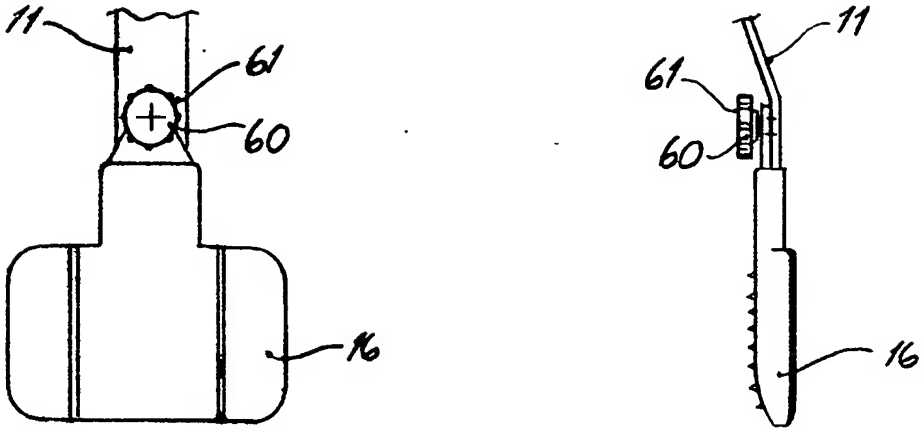

FIG. 7.

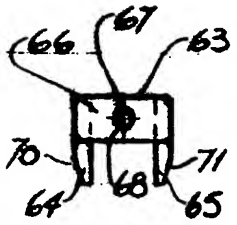

FIG 8a.

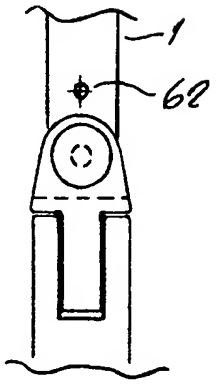

FIG. 8b.

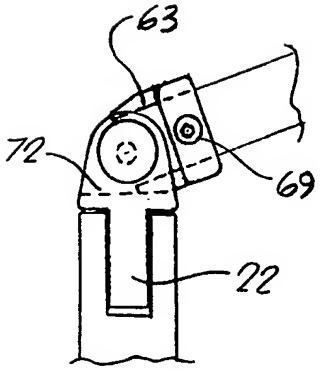

FIG 8c.

SPECIFICATION

An Orthopaedic Hip Hinge for Casts and Orthoses

This invention relates to a hinge used externally at or across the hip joint in conjunction with a belt or harness around the trunk also to casts and orthoses for at least the femoral portion of the leg.

Background to the Invention

There are a number of common and difficult orthopaedic problems associated with the hip joint where the use of an improved hinging system would be beneficial. These include:—

1. Legg Calve Perthes Disease (hereinafter referred to as Perthes Disease), a condition of children, especially boys.
2. Pathological fractures of the neck and the femur, a condition mainly of the elderly.
3. Post-operative care of the patient who has had a total replacement of the hip joint with a prosthetic joint (hip arthroplasty).
4. The inoperable patient with an osteoarthritic hip.

However, this is by no means an exhaustive list of conditions in which such devices could be beneficially applied.

The pathology of Perthes Disease is complex and is not fully understood. However, there is known to be an initial event which involves partial avascular necrosis in the growing part of the femoral neck. This is generally followed by a period of spontaneous re-ossification and healing.

During these processes, the femoral head and neck are usually somewhat plastic. Because of this, a variety of permanent physical deformities can result when healing and bone regeneration are complete and the patient has reached skeletal maturity. The main determinants of these deformities include the extent of the avascular necrosis, the pattern of closure of the growth plate, the degree of extrusion of the femoral head and of course, the treatment received by the patient during the course of the disease.

Pathological fractures of the femur, especially of the femoral neck, are very common in the elderly; rather less so in younger patients. They occur as part of the symptomatology of osteoporosis, osteamalacia (rickets in children) and Paget's disease of bone. The prognosis is highly dependent upon the underlying causes but there are many older patients in whom subsequent femoral fractures at a similar site do occur.

There is now known to be a group of patients in whom a hip arthroplasty procedure yields an unstable joint in which dislocation, usually fairly early in the rehabilitation period, is likely. Though the dislocation may be reduceable by manipulation, there appears to be a high risk of recurrence.

The fourth group of patients referred to are those with hip disease in whom although an operation, such as arthroplasty, would normally be the treatment of choice, other medical conditions preclude this option. Such a condition might be a marked impairment of respiratory capacity rendering the patient unable to endure general anaethesia, for instance.

The Prior Art

A great deal has been published on the use of orthoses in controlling the effects of Perthes disease but there is a smaller literature on the use of hinges and orthoses in the management of pathological fractures in the elderly and in the other groups.

Most authors strive to achieve the triple aims of abduction, controlled internal rotation and load relief of the femur. These measures are taken with a view to maintaining the diseased femoral head in its correct anatomical location and approximately normal orientation with respect to the acetabulum during regeneration of bone and healing, whilst at the same time minimising stress on the bone. By these means it is hoped that physical deformity will be minimised.

Typically, an orthosis for this purpose consists of a rigid hinged or non-hinged, medial, weight-bearing bar extending from the loading point on the ground to a suitable circumferential thigh member. Most proposed orthoses attempt to offload the femoral head and neck by making this circumferential thigh member weight distributing. It is generally provided in the form of a cast or vacuum formed component made of a suitable strong material and which bears against the ipsilateral inferior ischial ramus. Sometimes, by posterior and upwards extension, weight is distributed to the gluteals as well.

The desired degree of internal rotation of the leg is achieved by appropriate positioning and sometimes by contouring the orthosis, during fitting.

Orthoses conforming to this general pattern are the trilateral orthosis of Tachdijian and Jouett, the Mainz hip relieving orthosis of Volkert and Steeger, the Pogo Stick brace of Glimcher, Radin and Amrich and the abduction orthosis of Birkeland and Zettl. There are some differences in the function of these orthoses insofar as the intention that the affected side should or should not bear substantial weight through the medial bar but they are remarkably similar in appearance. Most of these orthoses are described and illustrated by C. Fillauer and C. H. Pritham in 'Fabrication and Fitting Instructions: Trilateral Perthes Orthosis' (Orthot. Prosthet. 1983—84 37 (4), 34—42).

All of them are clumsy, heavy unsightly and difficult and time consuming to fit even by skilled persons, furthermore they take a long time to get on and off a child in the morning and at night, particularly if it will not co-operate.

Amongst other types, the Toronto Orthosis provides only the elements of internal rotation and abduction; it is not weight bearing. Hoffman (Inter-Clinic Information Bulletin, Vol 18, No. 5, Winter 1983) has described hip-rotation control straps but these do not provide abduction or weight bearing and were designed more with the spina-bifida child in mind. The Scotish Rite orthosis only provides abduction.

H. Legal described the Erlangen Hip Orthosis in Med. Orthop. Tech. 1983 103, 49—53. This compact and functional orthosis is used on patients with severe osteoarithritis who are not suitable for, or who are waiting for, total hip replacement; it is also used on unstable hips and in those patients who have undergone a Girdlestone pseudoarthrosis.

In this procedure the femoral head is removed and bears only on fibrous and scar tissue at the side of the former hip joint; there is considerable leg shortening and gait disturbance as well as pain and instability. The Erlangen orthosis is not, however, described for Perthe's disease. Clearly it will provide control of internal rotation and if the distal portion were to be attached very tightly, some small offloading of the femur might be achieved through the lateral member and belt. Abduction, however, especially to the 30 degrees of so which most authors recommend for Perthes disease, does not seem to be intended or contemplated.

The single axis hip hinge made by Messrs Blatchfords Limited of Basingstoke, Hampshire, England and sold in the United Kingdom and Europe by Messrs Smith and Nephew as Dynabrace, was described by B. F. Meggitt and T. Vaughan Lane in Prosthetics and Orthotics International 1980, 4:3 under the title 'Hip hinge thigh brace for early mobilisation of proximal femoral shaft fractures'.

So far as we are aware, this hinge has only been promoted for cast bracing of proximal femoral shaft fractures and has not been actively promoted for use in Perthes disease. Nevertheless, a number of British hospitals known to us have attempted to use it as the principal component in a Perthes orthosis. It is not adequate for this purpose of several reasons:—

1. The hinge has only a single axis. If abduction is to be achieved, the hinge must be bent quite drastically and is then called on to function for many months whilst subjected to a severe bending moment and repeated reversals of stress along a 'live' axis i.e. a bending axis which lies outside the line of the hinge. Even though fabricated from a strong aluminium alloy, it is doubtful whether the hinge arms possess adequate margins of strength in this condition.
2. The end or head plate fitted to this hinge is made of metal and is rivetted to the lower hinge arm. This type of headplate/hinge arm arrangement is adequate for use in simple casting with Plaster of Paris and some of its derivatives. However, it generates dead space and lacks positive capture in casts made of modern casting materials. These are much more suitable for long term applications such as a Perthes orthosis where their lightness is a great advantage.
A fuller discussion of the disadvantages which one of us (D.E.Y.) and D. H. Boyes has demonstrated with this type of headplate is given in our co-pending application, published specification number GB 2,130,488.
3. The harness and waistband of this hinge are too narrow and too lightly constructed for long term use in a Perthes orthosis.

For the management of unstable hips and pathological fractures, the Dynabrace hinge has no advantages over the Erlangen orthosis, requires additional components to provide an orthosis and still shares with that device the prime disadvantage of being uniaxial.

Objects of the Present Invention

It is an outstanding object of the present invention to provide a hip hinge with two axes of motion arranged at right angles to one another. The first axis to lie horizontally such that motion about it will generally be forwards and backwards (antero-posterior) so that the leg may be elevated and depressed normally. The second axis also to lie horizontally, such that motion about it will allow abduction or adduction of the hip to which it is fitted.

It is another object of the present invention to provide a hip hinge with two axes of motion lying at right angles to one another, both axes in a horizontal plane such that the axis which allows adductive and abductive motion is lockable at preferred points or free as decided by the patient's medical attendant.

It is a further object of the present invention to provide a hip hinge with a belt and harness sufficiently robust and comfortable for long term use but capable of being replaced during use.

It is yet a further object of the present invention to provide a hip hinge with a headplate suitable for use with lightweight modern casting materials and which can be detached at night if this is deemed useful and safe by the patient's medical attendant.

It is yet a further object of the present invention to provide a hip hinge of great inherent strength so as to be suitable for long term single patient use, whilst at the same time being compact in design and capable of being worn under ordinary clothes in most circumstances.

It is yet another object mf the present invention, by virtue of fulfilling the objects described above, to provide a hip hinge which can be combined with other suitable elements comprising, at least, an anti-rotation femoral cast or orthotic with an ischial/gluteal bearing surface to provide a Perthes orthosis which gives an appropriate degree of internal rotation, appropriate abduction and offloading of the femoral neck.

It is yet another object of the present invention to provide a hip hinge for incorporating into cast braces for the management of fractures of the proximal femoral shaft and pathological fractures of the femoral shaft and neck.

It is still a further object of the present invention to provide a hip hinge, for incorporation into suitable orthoses and casts for the management of unstable hips, whether due to threatened or actual dislocation of a total hip prosthesis, the same in the natural hip joint, the severely diseased and inoperable hip joint, pseudoarthroses and other hip conditions in which the use of a hip hinge with a facility for limiting flexion, could be indicated.

With these and other objects in view as will be apparent to those skilled in the art, the invention

resides in the combination of parts set forth in the specification and covered by the claims appended hereto.

Summary of the Invention

The invention provides an orthopaedic hip hinge made in very strong metal which is conveniently stainless steel.

There is provided an upper hinge arm with an offset formed in it during manufacture, the effect of which is to step it out from the patient's waist at its upper end where it is mounted on a horizontal metal waist band. The waist band is firmly attached within a belt which is attached in turn to a shoulder harness designed to be worn over the contra-lateral shoulder. Both belt and shoulder harness are adjustable.

There is also provided a lower hinge arm, also with a factory formed offset. At its lower or distal end, there is provided a plastic headplate exhibiting all salient features of headplates disclosed in co-pending published specification Number GB 2,130,488 and European Publication Number EPN 0 109 847.

Between the hinge arms lies a bi-axial hinge mechanism. There is provided an upper 'T' bracket, the crossbar of which is formed with a boss which functions as a bearing for the upper hinge arm. This is retained in place by a strong escutcheon plate. This assembly provides the first horizontal axis for forwards and backwards (antero-posterior movement.

The leg of the 'T' bracket fits intimately into a broad slot or yoke in an angle locator and is secured there by a bearing pin running through a transverse hole near its upper end. The lower end of the leg of the 'T' bracket has another transverse slot shaped hole which can be lined up with any of three matching tranverse holes which pass right through both arms of the yoke in the angle locator. By this means the hinge may be made neutral or abducting to a nominal 15 or 30 degrees, according to which of the three holes is selected. The setting is locked by passing a hardened steel shoulder screw through one pair of yoke holes and the 'T' bracket slot.

Alternatively, the pin can be omitted, in which case the hinge will allow free abduction and adduction as well as elevation, depression and rearwards extension of the hip joint; this is to say it will function as a universal joint.

A threaded hole in the upper hinge arm, lies outside the escutcheon plate and accepts, optionally, a flexion restrictor plate.

Brief Description of the Drawings

In order that the invention may be more clearly understood, reference will now be made to the accompanying drawings in which:—

Figure 1a shows a front view of a preferred embodiment with the belt and harness omitted.

Figure 1b shows a detail of the hinge mechanism and the terminations of the hinge arms.

Figure 2 shows a side view of a preferred embodiment including an outline of one of the alternative adjustment positions.

Figure 3a shows a front view of the angle locator.

Figure 3b shows a partially sectioned front view of the angle locator.

Figure 3c shows a side view of the angle locator.

Figure 4a shows a front view of the 'T' bracket.

Figure 4b shows a side view of the 'T' bracket.

Figure 5 shows the escutcheon.

Figure 6a shows the belt and harness layout.

Figure 6b shows the construction of the belt.

Figure 6c shows a section of the belt through the pocket with the waistband in situ.

Figure 6d shows a detail of the waistband and the means of securing it to the belt.

Figure 6e shows a detail of the waistband and belt in the assembled condition.

Figure 7 shows alternative headplate securing means for repeated removal and fitting at will.

Figure 8a shows a detail of the hinge mechanism and upper hinge arm.

Figure 8b shows a front view of a flexion restrictor plate.

Figure 8c shows a detail of the flexion restrictor plate fitted to a hinge flexed to the limit position.

Description of a Preferred Embodiment

Referring first to Fig. 1a, in which an upper hinge arm 1, is conveniently blanked from stainless steel sheet, 4 mm thick and press-formed to provide a crank which may be 32 mm or may be provided in other sizes according to the size of patients in whom use is intended. Similarly, the developed length of the upper hinge arm is conveniently 114 mm or 89 mm according to whether use on an adult or a child is contemplated. It is conveniently 20 mm wide.

At the upper end of upper hinge arm 1, there are provided two holes 2 and 3, which align with similar holes (not shown) in a metal, preferably stainless steel, waist band 4, which may be 2 mm thick, 38 mm wide and 300 mm long such that the top of the hinge arm lies just flush with the upper edge 5, of the waist band. The waist band 4 and upper hinge arm 1, are secured together by stainless steel rivets 6 and 7. The rivetted fixing may be reinforced by welding. The lower part of the upper hinge arm 1, is cropped to a semicircular end 8, which is shown in outline in Fig. 1b, wherein is provided a hole for mounting the upper hinge arm to the hinging mechanism 9, by means of a screw 10.

A threaded hole 62, in upper hinge arm 1, is used to mount an optional restrictor mechanism which is described later.

A lower hinge arm 11, is produced by the same method in the same material and conveniently has a crank of 12 mm, a developed length of 184 mm and a width of 20 mm. As shown in Fig. 1b, it has a square cropped upper end 12, and is pierced with holes for location and attachment to the hinging mechanism 9, by means of screws 13 and 14.

The use of upper and lower hinge arms, in which offsets or cranks are factory formed, is disclosed in published specification EPN 0 109 847 which claims priority from United Kingdom application number 8312293.

The lower end of the lower hinge arm 11 is fitted with a headplate 16, illustrated in Fig. 2. The

preferred headplate is conveniently moulded in high density polyethylene and has a blind slot 17, illustrated by broken lines in Fig. 2, sized to accept the lower hinge arm by a push fit. Headplate 16, is generally rectangular in plan and is concavo-convex in section (not illustrated); it has splines 18, on both its upper 19 and lower 20, surfaces as shown in Fig. 2. The splines engage positively with all casting materials in common use and with many orthotic materials such as those based on polycaprolactones. The headplate 16, is also formed with secondary flex grooves 21, shown in Fig. 1a, by means of which excellent conformability to the limb and cast may be obtained. The headplate 16, is secured by a screw 15.

The features and design elements of the preferred headplate are fully described in the published specifications GB 2,130,488 and EPN 0 109 847; also in United Kingdom application 8312293 from which the European publication claims priority.

The general layout of the hinging mechanism 9, is shown in Fig. 1a and can be seen to consist of two main parts. These are a cranked 'T' bracket 22 and an angle locator 23, both of which are preferably stainless steel investment castings, suitably deburred and having a high quality, smooth surface finish, such as may be achieved with the well known process of bead blasting. In Fig. 4a, it can be seen that the upper part or crossbar 24, of the 'T' bracket has an upwards extension 25, with a rounded margin 26. In Fig. 4b, the upwards extension 25, can be seen to carry a boss 27, which is the bearing for the upper hinge arm 1, of Fig. 1a. The boss 27, has a threaded through-hole 28, shown in broken lines.

In Fig. 5, an escutcheon plate 29, is shown. This is also a stainless steel investment casting, finished in the same way as the other cast parts. This escutcheon plate fits over the boss/bearing 27, of Fig. 4b and is secured through a central countersunk hole 30, with a hexagon-drive screw as shown in Fig. 1b, 10. By this means, the upper hinge arm is retained on the bearing. To impart good running characteristics to this bearing and to control side-float, the assembly is lightly greased and as shown in Fig. 2, is fitted with washers 31 and 32, on each side of the upper hinge arm 1.

This assembly constitutes the provision of the first hinge axis which allows elevation, depression and rearwards extension of the hip.

As shown in Fig. 4b, the leg 33, of the 'T' bracket, is cranked to 30 degrees and has a transverse hole 34 and a transverse slot 35, also shown in Fig. 4a, by broken lines.

In Fig. 3a, the angle locator 23, can be seen to be more or less rectangular in plan but with a cutaway portion to form a yoke 36, which accepts the 'T' bracket leg 33. Fig. 3c, reveals a raised section 37. This has a recess 38, on one side only in which are located three identical holes 39, 40 and 41, which pass right through the yoke 36. These holes are threaded only on the far side of the yoke from the recess as indicated for hole 41 only, in the sectioned portion of Fig. 3b.

Fig. 3b, also shows a fourth, non-threaded hole 42, near the upper end of yoke 36. When 'T' bracket leg 33, is assembled accurately to yoke 36, as shown in Fig. 1a, holes 34 and 42, align. They are secured in this position with an expanding pin, such as a Bissel pin 43, shown in Fig. 2. By this means is provided the second axis, at right angles to the first but still lying in a horizontal plane.

As shown in Fig. 3c, the centre of hole 41, is pitched at 30 degrees to that of hole 39 and the centre of hole 40, is pitched on a line bisecting this angle. The centres of all three holes 39, 40 and 41, lie on arcs of circles which are concentric with hole 42.

This arrangement allows fixed abduction of the hip at a nominal 15 or 30 degress to be imposed if required, or otherwise free abduction and adduction at will.

Fixed abduction at a nominal 30 degrees is shown in outline in Fig. 2. Referring to Figs. 3b and 4a, the abduction is imposed by the insertion of a suitable partially threaded shoulder pin or screw (not shown), having a head depth equal to, or slightly less than the depth of recess 38, into the non-threaded (recessed) end of hole 39, whilst keeping this aligned with slots 35 in the 'T' bracket leg 33. The shoulder pin is passed right through slot 35, to engage the threaded portion of hole 39 and tightened up.

If abduction is required to be fixed at 15 degrees, the procedure of the preceding paragraph is applied with hole 40, aligned with slot 35.

If abduction is required to be fixed at 0 degrees, the procedure of the preceding paragraph is applied with hole 41, aligned with slot 35.

For unrestricted abduction and adduction, the shoulder pin is omitted.

We have found by measurement in children and adults of small to moderate size, that a nominal setting of the hip hinge at 30 degrees does not cause a marked increase above this figure in the actual angle subtended at the femoro-acetabular junction. This is because the femoral neck is quite short and the tissue overburden at the hip is not unduly great.

In very large and fat patients, however, the same setting could result in markedly increased true abduction angles. In these patients it is preferable to use hole 40, pitched between holes 39 and 41, to provide a nominal hinge offset of 15 degrees. In other patients also, when smaller fixed abduction angles are required, this setting can be used advantageously.

The layout of the belt 44 and harness 45, which are constructed mainly from fabrics, is shown at Fig. 6a. The belt 44, is broader than the metal waistband 4, by an amount which allows a sturdy, sewn, partly open-bottomed pocket 46, shown in dotted lines in Fig. 6a, to be formed near one end. The belt may be reversed for left or right sided use.

As shown in Fig. 6b, the belt is conveniently constructed of a layer of strong polyester material 47 which is comfortable and conformable and which has a pile on the external surface. This is reinforced with a layer 48, of strong binding, preferably of the kind known to those skilled in the art as petersham. The inner layer of the belt 49, is identical to the outer layer. The material from which the inner and outer layers are made transmits sweat and is non-chafing.

In Fig. 6c, a section of the belt 44, through the pocket 46, shows that the metal waistband 4, is held firmly in place by the belt fabrics. This is achieved by making the pocket 46, a tight sliding fit over it.

Although it is important that once fitted, the metal waistband 4 and belt 44, are firmly engaged one with the other, assembly and dismantling must also be facilitated so that the belt 44 and harness 45, may be changed during the course of long term use.

As shown in Fig. 6d, this is facilitated by making the opening 50, in the lower part of the pocket 46, slightly more than half the length of the metal waistband 4, say 170 mm in the case of a 300 mm waistband. With the waistband, in place, opening 50, in the lower margin of the belt is closed by loop closure strips 51 and 52, sewn to the inner or outer layer of the belt 44. The pile material from which these layers are made provides a closure when pressed against the loop strips 51 and 52.

As shown in Fig. 6e, the loop strips 51 and 52, are arranged such that when the metal waistband 4, is properly assembled to the belt 44, said strips lie equidistant from upper hinge arm 1.

By way of example from Figs. 6d and 6e, the left hand end of metal waistband 4, is first pushed firmly into the left hand end of opening 50, until the right hand end of the metal waistband 4, can be located in the pocket 46. Metal waistband 4, is now slid along to the right of the pocket until upper hinge arm 1, lies centrally between the loop strips 51 and 52 which are then closed.

It will be appreciated that in this position, almost half of the lower edge of metal waistband 4, is supported by a sewn segment 53 and the remainder is supported by the loop and pile closures.

It will be appreciated from Fig. 6a, that the belt 44, is intended for ventral closure and adjustment. This is achieved by a loop strip 54, on one end and a flat rectangular ring buckle 55 on the other. This allows a very wide range of adjustment.

The harness 45, has loop strips 56 and 57, at both ends. The ventral strip 56, is passed through a slip ring 58, sewn on by a fabric tag 59 and is secured adjustably to the pile polyester material of the harness itself. The dorsal strip 57 is passed around the belt 44 and this is also secured adjustably to the pile of the harness material.

The embodiment described here is preferred for use on single hips, left or right and could be made conveniently in two standard sizes, say up to 71 cm waist and 71 cm to 102 cm waist.

In use, with the belt 44, adjusted and closed, the harness 45, is secured to the belt in the middle of the back and passed over the contra-lateral shoulder and through the ring 58. The harness 45, is then adjusted to provide tension on the hip-hinge.

Other versions of the belt, made according to the general principles disclosed herein, especially in relation to the pocket 46, can be used when the hip-hinge is employed bi-laterally. Two variations from the basic layout (not illustrated) may be needed.

One is the provision of a second shoulder harness, originating at the same point as the first, or from some point on the first, constructed from the same material and having the same means of adjustment and closure.

The other is secondary adjusting means on the belt, so that the absolute and relative position of the two hip-hinges may be set and then maintained. This allows the basically ventral closing and adjusting position to be retained. We prefer a sliding adjuster, well known in the art, for this purpose.

It should be understood that the embodiment hereinbefore described is preferred for general purpose work only and there will be many occasions when special or particular belts of different types are required to be used with the preferred embodiment of the hinge itself.

Referring now to Fig. 8a, there is shown a flexion restrictor plate 63. This is provided for optional use on upper hinge arm 1, of Fig. 8b, when it is desired to restrict the flexion axis of the hinge and thereby limit flexion of the hip. This is of value in dealing with actual or potential dislocation of an artificial hip joint since it has been shown that this is most likely to occur when the hip is flexed to high angles in the region of 90 degrees.

The restrictor plate 63, is conveniently made in one piece of metal by the well known process of die-casting. Plate 63, is in the form of a channel made up by legs 64 and 65, so spaced apart by an integral face-plate 66, as to provide a fit over upper hinge arm 1, of Fig. 8b. Face plate 66, has a central unthreaded hole 67, in a recess 68.

From Figs. 8b and 8c, it can be seen that plate 63, is attached to upper hinge arm 1, by means of screw 69, which passes through unthreaded hole 67, into threaded hole 62, in said upper hinge arm 1. The head of screw 69, is accepted non-protrudingly into recess 68.

Legs 64 and 65, are the same thickness as upper hinge arm 1 and have angled faces at their lower ends 70 and 71. When the hinge is flexed to the limit position, as shown in Fig. 8c, one angle faced lower end 70 or 71 according to whether the hinge is being used on a right or a left hip, abuts the upper internal surface 72, of 'T' bracket 22, so preventing further flexion. For general use, we prefer plate 63, to be configured to restrict flexion to 70 degrees. However, other restrictors with angles of say 40, 50 and 60 degrees may be used sequentially to progressively de-restrict the hip joint.

Use and Development of the Preferred Embodiment

When the medical attendant wishes the hip hinge to be worn all the time, or when it is desired that it should remain an integral part of a cast brace or orthosis, the headplate 16, is secured to the lower hinge arm with a screw, such as an M5×6 mm positive drive screw 15, shown in Figs. 1a and 2. In such a case, the head of the screw can be covered over with cast or orthosis material, if so desired, to render it completely tamper-proof.

However, if it is required to make the hinge, together with the belt and harness, removable from a thigh cast or orthosis on a regular basis, an alternative headplate securing screw 60, shown in Fig. 7, is used. This screw 60 has a button top 61 and has a diameter not greater than the width of the

lower hinge arm 11. The button screw 60, can easily be removed or replaced, tightened or loosened, as required, by most patients. To prevent its being lost, the button screw may be attached to either the lower hinge arm 11, or the headplate 16, by means of a suitable plastic tag or rubber band. The use of a removable headplate is advantageous in the Perthes application where the orthosis applied to the thigh may have to be replaced when a young patient outgrows it during treatment.

We also contemplate the use of the present invention, without a headplate, where the lower hinge arm is built directly into an orthosis which could still be made removeable from the leg by, for instance, using buckle and strap mechanisms in the thigh component such as those disclosed in our co-pending United Kingdom applications, numbers 8406357 and 8430899. Furthermore, we contemplate and have done experiments on, use of the hinge mechanism, without hinge arms, as a component in other orthopaedic devices, including caliper orthoses.

Again, we have contemplated embodiments in which hinge arms are made without pre-formed offsets and others, where offset or not, other metals including aluminium alloys are used.

Yet again, we have contemplated and constructed hinge mechanisms, according to the principle disclosed hereinbefore, in which other metals than stainless steel and other methods than investment casting were used to produce them. We have also contemplated the use of plastics, especially the use of fibreglass filled nylon, for components of the hinge mechanism.

We have found by experiment and in wearer trials that the arrangement of a cranked 'T' bracket 22 and raised portion 37, on the angle locator 23, to be the least obtrusive method of providing the necessary range of adjustment. This is because raised portion 37, is outboard and generally encloses cranked 'T' bracket leg 33, so there is no risk of the latter impinging on the cast or orthosis at normal levels of abduction. In fact, the impingement condition can only be reached in 'free' mode at abduction angles close to the limit for normal hips—such as might be reached in hurdling, for example, which are well outside the range of application of the device.

If 'T' bracket leg 33, was made straight, then with the hinge set in the 30 degrees abduction position, or during abduction of that order in 'free' mode, the lower part of it could strike the cast or orthosis since it would be well inboard of the angle locator.

Before arriving at the preferred embodiment, we also constructed prototypes of the present invention with greater ranges of adjustment, 'semi-free' modes of abduction and small ranges of abduction within fixed limits, all employing the general principles disclosed herein. However, the hinge mechanism was bulkier and heavier. There also appears to be no overall clinical benefit in increased adjustment possibilities.

The offsets disclosed for upper and lower hinge arms 1 and 11, are adequate for most people. Some patients, including small children, may require a larger offset in the top arm and this has been measured in some cases to be as much as 42 mm.

Such cases need a hinge with an adequate offset built-in; it is not possible to bend this or any other extant hip hinge to such a large increase in offset on site with the necessary accuracy and without the risk of damage to the metal. In particular, there is a risk of scraping up shards on the surface of a hinge arm; these put the patient at risk from cuts. Also, the pitch of the hinge would be drastically altered and possibly ruined.

However, minor adjustments in pitch can be made. This can be desirable when, for instance, the offsets are adequate but the distractions obtained with the hinge abducting axis need to be modified during treatment, perhaps because the patient is growing fast or gaining weight. The same requirement is occasionally met with in a patient who has had a previous fracture of the femoral shaft which has healed with marked angularity.

Although adjustments can be made at any bend, this is preferably done at the lower off-setting bend 62, in Fig. 2, of the lower hinge arm 11. Our second preference is the lower off-setting bend 63, in upper hinge arm 1. The safest and easiest method is to use a proper jig which we have designed for pitch-trimming of orthapaedic hinges and which is supplied commercially by Seton Products of Oldham, Lancashire, England. If such a jig is not readily available, angular adjustments can be made in a bench mounted vice preferably fitted with soft jaw-guards to prevent damage to the metal surface.

Regarding the use of restricted flexion, we recognise that in some circumstances it will be required to progressively derestrict the hip joint and we contemplate that the restrictor plate 63, of Fig. 8a, would be supplied in several versions, each having different angled lower ends to accommodate this need. In addition, the same principles of a plate with legs as stop means, fixed to the upper hinge arm can be used to provide a locking feature and an adjustment feature should this be required.

For example, the restrictor plate may be made into a locking plate by extending part of the lower edge of the faceplate downwards at the required angle so that it will only locate at the desired locking angle. An adjustable version uses an enlarged faceplate with a plurality of fixing holes which mate with a plurality of accepting holes in the upper hinge arm. In this version, lower ends of the legs use curved abutment faces and for added strength, the component could be investment cast in stainless steel.

The preferred embodiment of this feature is selected on account of simplicity, lack of bulk, ease of use and minimal tendency to catch clothing or parts of the patient. We have experimented with a variety of other embodiments which employ a plate or other structure providing abutment means between the upper hinge arm and the hinge mechanism to limit flexion of the upper hinge axis. As indicated above, previously proposed Perthes orthoses are bulky, clumsy, heavy and restrictive to use. Previously proposed hip hinges have had only a single axis for elevation and depression and are

not suitable for use in Perthes orthoses. Furthermore, hip hinges of the prior art have not proposed means of achieving restriction of flexion.

In contradistinction, the present hip hinge has a novel, adjustable abducting axis, as well as a restrictable axis for elevation and depression and may be used, by virtue of its headplate, with modern lightweight casting materials to produce a light simple Perthes orthosis which can be worn under normal clothing. If preferred, the present invention can be used with any casting material, suitable knee hinges and adjusting methods, such as those described in the co-pending applications cited above, to produce a knee, ankle, foot orthosis.

Furthermore, the present hip hinge can be used to good effect in cast bracing of fractures of the proximal third of the femoral shaft and pathological fractures of the femur as well as for supporting unstable hip arthroplasties. The novel use, in hip hinges, of pre-formed offsets to eliminate or minimise, the effort and damage which is involved in on-site shaping of prior art hip hinges, together with the use of stainless steel throughout, give the present hip hinge much higher safety margins in regard to compression and bending stress loading in long term service.

The invention having been thus described, what is claimed as new and desired to secure by Letters Patent is:

CLAIMS

1. An orthopaedic hip hinge for use in conjunction with, or as a component of, casts or orthoses, wherein the hinge mechanism provides first and second horizontal axes of motion, the first of said axes accommodating flexion and extension motion of the hip, the second of said axes accommodating abductive and adductive motion of the hip.

2. A hinge as claimed in Claim 1, wherein the first axis is provided with means of optionally restricting the angular range of flexion and extension motion.

3. A hinge as claimed in Claim 2, wherein the restricting means comprises a restrictor plate having legs spaced apart by an integral face plate such that said restrictor plate fits closely over an upper hinge arm to which it is attached by screw means, said legs having angled faces on their lower ends which abut the hinge body at the desired angular limit of travel.

4. A hinge as claimed in Claim 1, wherein the second axis is provided with optional adjustable locking means for setting abduction to a plurality of fixed positions.

5. A hinge as claimed in Claim 4, wherein the adjusting means of the second axis are mounted in such a way that during abduction, said means are outboard of, or lateral to, the antero-posterior plane of the hinge.

6. A hinge as claimed in Claims 4 and 5, wherein the adjustment and locking means of the second axis are in the form of a locking pin which is accepted into one of a series of holes in a recess in one component of said axis mechanism and engages intimately with a slot in another component of said axis mechanism.

7. A hinge as claimed in Claims 1—6, wherein are provided upper and lower hinge arms made of metal.

8. A hinge as claimed in Claim 7, wherein at least one hinge arm is provided with medio-lateral offsets formed at the time of manufacture.

9. A hinge as claimed in Claims 1—8, wherein the principal hinge mechanism components are made in metal by casting.

10. A hinge as claimed in Claims 1—9, wherein at least one hinge arm is fitted with a headplate for incorporating into a cast or orthosis.

11. A hinge as claimed in Claim 10, wherein means are provided to enable the hinge to be repeatedly removed from and re-fitted to the headplate.

12. A hinge as claimed in Claims 10 and 11, wherein the headplate exhibits the salient features of headplates described in the co-pending British application having the published specification number GB 2,130,488 and the pending European application having the published specification number EPN 0 109 847.

13. A hinge as claimed in Claims 1—12, wherein the upper hinge arm is fitted with a waistband.

14. A hinge as claimed in Claim 13, wherein the upper hinge arm and waistband are integral.

15. A hinge as claimed in Claims 13 and 14, wherein the waistband is provided with an adjustable belt and harness.

16. A hinge, substantially as hereinbefore described, with reference to Figures 1 to 8c of the accompanying drawings.

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